

### REMARKS

In response to the final office action dated August 14, 2008, Applicants amended claims 1 and 10. Claims 1-10, 12-20, and 22-24 are presented for examination.

The Examiner rejected claims 1-10, 12-20, and 22-24 as being obvious over Cravino et al., *J. Mater. Chem.*, 2002, 12, 1931-1943 (“Cravino”) in view of Sentein et al., *Optical Materials*, 9 (1998) 316-322 (“Sentein”) and Zhao et al., *Polymer*, 1995, 36(11), 2211-2214 (“Zhao”).

Applicants discuss claims 19, 20, and 22-24 first. Claims 19, 20, and 22-24 cover methods of treating a photovoltaic cell. The methods include heating the photovoltaic cell to above a glass transition temperature ( $T_g$ ) of an electron donor (e.g., a conjugated polymer). As correctly pointed out by the Examiner, “[n]either Cravino nor Sentein teach[es] the heat treatment being above a glass transition temperature of the conjugated polymer.” See the final office action, page 4, third last paragraph.

Zhao does not cure this deficiency in Cravino or Sentein. Zhao describes a study on the phase transitions of poly(3-hexylthiophene) (P3HT) by Differential Scanning Calorimetry. See, e.g., the abstract. However, Zhao is completely silent on a photovoltaic cell, let alone heating a photovoltaic cell above the  $T_g$  of an electron donor in the photovoltaic cell, as required by claims 19, 20, and 22-24.

The Examiner asserted in the final office action that

“Zhao teaches a heat treatment being above a glass transition temperature ( $T_g$ ) of the conjugated polymer (Results section, ¶ 3, ‘a higher crystallinity can be obtained at higher crystallization temperatures’) to provide increased crystallization (order) which has the advantage of reducing potential barrier (Sentein: 5, ¶ 1).” See the paragraph bridging pages 4-5; emphasis added.

Applicants respectfully disagree. Zhao describes that P3HT has two separated crystal formation processes, i.e., a fast process and a slow process. See, e.g., the abstract. According to Zhao, “[f]or the fast process, ... A greater heat of transition, i.e., a higher crystallinity, was achieved at lower crystallization temperatures. As for the slow process, ... A higher crystallinity can be obtained at higher crystallization temperatures.” See the paragraph bridging pages 2212 and 2213; emphasis added. In other words, the statement “a higher crystallinity can be obtained

at higher crystallization temperatures” quoted by the Examiner is only directed to the slow process of the P3HT crystal formation processes described in Zhao. By contrast, the fast process described in Zhao gives an opposite result. Further, as shown in Figure 3 of Zhao, the heat of transition of the fast process (i.e.,  $\Delta H_{m,f}$ ) at the crystallization temperatures of 80 °C, 110 °C, and 128 °C is in the range of 0.6-0.8 kJ/mol, while the heat of transition of the slow process (i.e.,  $\Delta H_{m,s}$ ) at the same crystallization temperatures is in the range of 0-0.2 kJ/mol. Given that  $\Delta H_{m,f}$  is significantly larger than  $\Delta H_{m,s}$ , one skilled in the art would recognize that the fast process is the dominant crystal formation process for P3HT and that the overall P3HT crystal formation process produces a greater heat of transition, i.e., a higher crystallinity, at a lower crystallization temperature, not at a higher crystallization temperature as asserted by the Examiner.

It appears that the Examiner based her rejection merely on a portion of the teachings in Zhao. Applicants would like to point out that “[t]he test for obviousness is what the combined teachings of the references would have suggested to one of ordinary skill in the art, and all teachings in the prior art must be considered to the extent that they are in analogous arts” (emphases added). See MPEP 2143.01. As discussed above, Zhao teaches that that the overall P3HT crystal formation process produces a greater heat of transition, i.e., a higher crystallinity, at a lower crystallization temperature. Thus, in view of all teachings in Zhao, it would not have been obvious to one skilled in the art that a higher crystallinity in P3HT can be obtained at higher crystallization temperatures, as asserted by the Examiner. It follows that it would not have been obvious to one skilled in the art, in view of all teachings in Cravino, Sentein, and Zhao, to heat a photovoltaic cell above a  $T_g$  of an electron donor, as required by claims 19, 20, and 22-24. Thus, claims 19, 20, and 22-24 are not obvious over Cravino in view of Sentein and Zhao.

Applicants now turn to claims 10 and 12-18. Claims 10 and 12-18, as amended, cover methods that include heating a photovoltaic cell containing an electron donor and an electron acceptor in a photoactive layer, while simultaneously subjecting the photovoltaic cell to an electric field. The electron acceptor (e.g., a fullerene) is a compound different from the electron donor (e.g., a conjugated polymer).

Cravino describes a double-cable polymer that contains fullerene moieties covalently grafted on to a conjugated polymer and use of this double-cable polymer in a photovoltaic element. See, e.g., the abstract. In other words, Cravino describes using only one compound

(i.e., a double-cable polymer) in a photovoltaic element. Cravino does not disclose or render obvious heating a photovoltaic cell containing two different compounds in a photoactive layer, while simultaneously subjecting the photovoltaic cell to an electric field, as required by claims 10 and 12-18.

Sentein does not cure the deficiency in Cravino. Similar to Cravino, Sentein also describes a device containing only one compound, i.e., a diode-like copolymer DR1-MMA-50/50, in its photoactive layer. See Sentein, section 2, 1<sup>st</sup> paragraph. Thus, even if Cravino and Sentein were combined, the results would not have been the methods of claims 10 and 12-18, which require heating a photovoltaic cell containing two different compounds in a photoactive layer, while simultaneously subjecting the photovoltaic cell to an electric field. Indeed, as explained in Applicants' response filed on May 2, 2008, Sentein teaches that a photoactive layer containing only one compound offers a crucial advantage over photoactive layer containing two compounds. In other words, Sentein **teaches** one skilled in the art **away** from the methods of claims 10 and 12-18.

Zhao also does not cure the deficiency in Cravino and Sentein at least because Zhao is completely silent on a photovoltaic cell, let alone a photovoltaic cell containing two different compounds in a photoactive layer, as required by claims 10 and 12-18. Thus, claims 10 and 12-18 are not obvious over Cravino in view of Sentein and Zhao.

Of note, the Examiner asserted in the final office action that "as amended, claims 10-19 and 22-24 do not require two separate compounds." See the paragraph bridging pages 8 and 9. Applicants do not agree with the Examiner assertion. However, to expedite prosecution, Applicants have amended claim 10 so that pending claims 10 and 12-18 explicitly require a photoactive layer containing two separate compounds.

Finally, Applicants discuss claims 1-9. Claims 1-9, as amended, cover methods that include heating a photovoltaic cell containing two different compounds, i.e., a conjugated polymer and a fullerene, above a  $T_g$  of the conjugated polymer for a predetermined treatment time. The heat treatment of the photovoltaic cell is carried out for at least a portion of the treatment time under the influence of an electric field.

As discussed above, none of Cravino, Sentein, and Zhao discloses or renders obvious heating a photovoltaic cell containing two different compounds under the influence of an electric

field, a limitation required by claims 1-9. Further, as also discussed above, none of Cravino, Sentein, and Zhao discloses or renders obvious heating a photovoltaic cell above a  $T_g$  of the conjugated polymer in the photovoltaic cell, another limitation required by claims 1-9. Thus, claims 1-9 are not obvious over Cravino in view of Sentein and Zhao.

Applicants submit that the pending claims are now in condition for allowance, an action of which is requested.

This reply is filed currently with a Request for Continued Examination. The required fee in the amount of \$810 is being paid concurrently herewith on the Electronic Filing System by way of Deposit Account authorization. Please apply any other charges to deposit account 06-1050, referencing Attorney's Docket No. 21848-0003US1.

Respectfully submitted,

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